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Occupational socioeconomic risk associations for head and neck cancer in Europe and South America: individual participant data analysis of pooled case–control studies within the INHANCE Consortium

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ABSTRACT

Background The association between socioeconomic disadvantage (low education and/or income) and head and neck cancer is well established, with smoking and alcohol consumption explaining up to three-quarters of the risk. We aimed to investigate the nature of and explanations for head and neck cancer risk associated with occupational socioeconomic prestige (a perceptual measure of psychosocial status), occupational socioeconomic position and manual-work experience, and to assess the potential explanatory role of occupational exposures.

Methods Pooled analysis included 5818 patients with head and neck cancer (and 7326 control participants) from five studies in Europe and South America. Lifetime job histories were coded to: (1) occupational social prestige—Treiman's Standard International Occupational Prestige Scale (SIOPS); (2) occupational socioeconomic position—International Socio-Economic Index (ISEI); and (3) manual/non-manual jobs.

Results For the longest held job, adjusting for smoking, alcohol and nature of occupation, increased head and neck cancer risk estimates were observed for low SIOPS OR=1.88 (95% CI: 1.64 to 2.17), low ISEI OR=1.74 (95% CI: 1.51 to 1.99) and manual occupations OR=1.49 (95% CI: 1.35 to 1.64). Following mutual adjustment by socioeconomic exposures, risk associated with low SIOPS remained OR=1.59 (95% CI: 1.30 to 1.94).

Conclusions These findings indicate that low occupational socioeconomic prestige, position and manual work are associated with head and neck cancer, and such risks are only partly explained by smoking, alcohol and occupational exposures. Perceptual occupational psychosocial status (SIOPS) appears to be the strongest socioeconomic factor, relative to socioeconomic position and manual/non-manual work.

INTRODUCTION

Globally, head and neck cancers, comprising cancers of the oral cavity, oropharynx, hypopharynx and larynx, account for over 700 000 new cases diagnosed and over 350 000 deaths each year, representing 4% of all new cancers in Europe and South America.[1 2] Worldwide, trends of these cancers are on the rise—particularly in the oropharyngeal cancer subsite.[3–5]

The major risk factors for head and neck cancer are tobacco use and alcohol consumption (particularly in combination), which comprise around 70% of the population attributable risk.[6 7] Human papillomavirus (HPV) infection is an emerging risk factor for oropharyngeal cancer.[8 9] Across all head and neck cancers, socioeconomic risk associations are comparable in magnitude to those of behavioural risk factors, with the greatest burden of head and neck cancer observed in those with the lowest incomes and education levels.[10] Tobacco smoking and alcohol consumption explain approximately two-thirds of the socioeconomic relationship, and this association persists when controlling for smoking or alcohol behaviour and among never smokers and never alcohol drinkers.[10] A previous systematic review and meta-analysis of published risk estimates found consistent elevated risk for oral cancer associated with low occupational socioeconomic position,[11] and an earlier small case–control study of larynx cancer suggested the occupational socioeconomic relationship was partly explained by smoking, alcohol consumption and substantially attributed to occupational exposures.[12]

The relationship between occupational-related socioeconomic factors and head and neck cancer risk has not been examined in detail. Socioeconomic classification of occupations is multidimensional and includes measures of occupational social position, prestige and class.[13 14] While occupational social classifications are largely related to the income and/or educational attainment required for the job, occupational social prestige explicitly relates to ranking of jobs based on normative admiration or respect.[15] Occupational socioeconomic prestige is derived from multiple factors such as psychosocial aspects, work stress, job control and social support networks.[13 14] Low relative to high and downward lifetime trajectories of occupational socioeconomic prestige have previously been linked with cancer risk[16] and particularly lung cancer in men.[15]

Here we investigate the risk associations of occupational social prestige, occupational socioeconomic position, and manual occupations for head and neck cancer. We thoroughly assess explanatory factors including smoking, alcohol and occupational exposures, and we explore differences in these risk associations by gender, global region, and head and neck cancer subsite.

METHODS

The original data studies of the International Head and Neck Cancer Epidemiology (INHANCE) Consortium (http://inhance.iarc.fr/) have been described in detail elsewhere.[6 17] Briefly, we used data from five frequency-matched case–control studies, which provided databases with occupational histories, containing occupational and industrial codes, in addition to the INHANCE pooled database (V.1.5). We included studies from Western Europe,[18] Latin America,[19] Germany (Heidelberg),[20] and two studies from France (1989–1991)[21] and (2001–2007),[22] which were all multicentre studies except for the German study. Online supplemental file 1 shows the main characteristics of these studies. We omitted participants with missing information on smoking behaviour (n=176), alcohol consumption (n=218), and missing or largely incomplete occupational history data (n=1071).

Cases comprised cancers of the oral cavity, oropharynx, hypopharynx and larynx. Control participants were recruited either in hospitals (France (1989–1991), Latin America) or in the general population (France (2001–2007), Germany (Heidelberg)). Both types of recruitment were used in the Western Europe study (online supplemental file 1).

Occupational socioeconomic position and prestige data

We assigned indices of socioeconomic position and prestige on the basis of participants' occupational histories, which contained job periods already coded by the International Standard Classification of Occupations of 1968 (ISCO68).[23] We considered occupational histories before retirement, reviewed all job periods, and deleted periods with missing or implausible information for ISCO68, start year or end year. We then excluded data of participants from the analysis if: their occupational history spanned less than 10 years, but only if they were also >30 years at the time of the study[15] ; and if less than 50% of their job history had ISCO68 codes.

We assigned Treiman's Standard International Occupational Prestige Scale (SIOPS) to the job histories.[24] SIOPS assigns prestige ratings to occupations, ranging from 14 (lowest prestige, for example, unspecified and unskilled agricultural workers) to 78 (highest prestige, for example, physicians). Based on the distribution of SIOPS scores among controls, we categorised the SIOPS score range into quartiles (14–30, 31–39, 40–48, 49–78). We also coded the jobs to the International Socio-Economic Index of occupational position (ISEI) in the version corresponding to ISCO68,[25] which comprises scores with a range from 10 (lowest position, for example, cook's helpers) to 90 (highest position, judges). As for SIOPS, we constructed quartiles based on the ISEI distribution in the control group (10–31, 32–39, 40–55, 56–90). Both, SIOPS and ISEI, were assigned on the basis of three-digit levels of ISCO68 codes. We further applied ISCO68 codes to manual and non-manual job groupings as previously described.[26] For analyses, from the coded occupational histories, we selected the longest held job for the primary analyses, but also assessed the first job, last job, the jobs with the highest ever reached SIOPS and ISEI scores, and 'ever employed in manual job', respectively.

Occupational data were further used to represent occupational exposure to carcinogens for head and neck cancer. We integrated the investigated ISCO68 categories in a new list of risk occupations (online supplemental file 2) where (a) ORs for the comparison of ever versus never having worked in an ISCO68 occupation were elevated and (b) if ORs were increasing for 10 or more years of employment. Our job history data did not contain sufficient information to accurately assign industries and assess their risk associations. Although based on results for men, we applied the new list of risk occupations to both men and women. We distinguished whether participants were ever employed in risk occupations for 10 or more years.[27 28] Finally, based on additional coding from three studies (Western Europe, France (2001–2007) and Germany (Heidelberg)), we characterised participants as ever or never having experienced unemployment.

Statistical analysis

We investigated head and neck cancer risk associations with occupational socioeconomic prestige, position, manual versus non-manual occupation and unemployment experience. We estimated ORs with 95% CIs by unconditional logistic regression. Based on a model adjusting for sex, age (years) and study centre (model 1), we added further variables in cumulative steps to study the impact on the investigated association. We first added cigarette smoking behaviour (smoking status (never, former, current), duration (years), smoking intensity (average daily amount of cigarettes) and cigarette pack-years (model 2)). Never smokers were participants who had smoked less than 100 cigarettes during their lifetime. Former smokers were participants who quit smoking more than 1 year before study participation. In the next step, we additionally considered alcohol consumption (model 3) by adjusting for drinking status (ever/never), drinking intensity, that is, average amount of alcoholic drinks per day (15.6 mL of ethanol per drink), and an interaction term of smoking (duration) and alcohol (intensity).[6] We further adjusted for ever/never employed in a risk occupation (at least 10 years) ('full' model 4).

Sensitivity and stratified analyses

We further adjusted for the respective other socioeconomic position and prestige variables (SIOPS, ISEI, manual/non-manual) (model 5). We applied model 5 to analyse unemployment, but did not adjust for unemployment due to the missing data. The main analyses were based on the longest held job. Additional sensitivity analyses involved using the first and the last job as well as the highest ever reached SIOPS/ISEI or 'ever employment in manual job', respectively. We alternatively included SIOPS and ISEI as continuous variables. All further analyses were also based on SIOPS for the longest job and the 'full' model. Analyses were stratified by sex, tumour subsite (oral cavity, oropharynx, hypopharynx, larynx), study region (Europe, Latin America), type of control recruitment (hospital or population-based), and single as well as combined stratification for ever or never use of cigarettes and alcohol. Further sensitivity analyses included exploring differences observed by study regions; and—using model 1—examining those participants who were initially excluded because of largely incomplete occupational histories. Finally, we performed multiple imputation on missing smoking and alcohol information (predicted on respective available smoking and alcohol data by age, sex and study centre), and recalculated model 4. All analyses were performed with SAS V.9.4 (SAS Institute).

RESULTS

We included 13 144 participants (5818 cases, 7326 controls) in the final analysis. Table 1 describes the study population. Lower categories of socioeconomic position and prestige indices were more frequent among cases. Only about one-third of overall cases had longest held jobs in the first or second quartiles of SIOPS and ISEI, respectively, whereas this proportion was about 50% among controls. Overall, 36% of cases compared with 22% of controls had ever worked in a risk occupation for at least 10 years, with lower proportions for women. Unemployment experience (data available for three of the five studies; approximately three-quarters of participants) was slightly higher for male cases than male controls.

Associations of occupational socioeconomic position and prestige are shown in table 2. For all indices, ORs increased with lower position/prestige. ORs were attenuated by all further adjustments, with the greatest effect through adjustment for cigarette smoking. Adjustment for alcohol consumption and employment in risk occupations only marginally reduced risk estimates. After adjustment for all behaviours and risk occupations, strong associations between low position/prestige and head and neck cancer persisted, with ORs for the lowest relative to highest categories of SIOPS: 1.88 (95% CI: 1.64 to 2.17), ISEI: 1.74 (95% CI: 1.51 to 1.99) and manual occupations: 1.49 (95% CI: 1.35 to 1.64). Accordingly, SIOPS and ISEI on a continuous scale were significant parameters in the fully adjusted model (online supplemental file 3).

In the model, mutually adjusting for other socioeconomic measures, SIOPS risk association remained OR 1.59 (95% CI: 1.30 to 1.94). Additional, sensitivity analyses showed risk associations were slightly lower for the first job, and elevated for the last job and highest SIOPS and ISEI (online supplemental file 4). The subgroup analysis of participants who had ever experienced unemployment showed slightly elevated risks for head and neck cancer in the fully adjusted model.

Results for the stratified analyses of risk associations are shown in table 3A,B for SIOPS, and in online supplemental file 5A,B) for both ISEI and manual/non-manual occupation. The risk associations were consistently lower for women than men. In contrast to the European studies, we did not find a similar strength of association in Latin America. When we stratified by tumour subsite, we found stronger associations for cancer of the larynx (OR 1.96 (95% CI: 1.60 to 2.42)) and hypopharynx (OR 2.61 (95% CI: 1.92 to 3.55)) than oral cavity (OR 1.63 (95% CI: 1.27 to 2.09)) or oropharynx (OR 1.68 (95% CI: 1.34 to 2.11)). Stratification by type of control recruitment showed increased ORs for population-based recruitment, and reduced ORs for hospital-based recruitment. Risk associations for low relative to high SIOPS reduced among never smokers and never alcohol drinkers (combined), with greater attenuation associated with never smokers (only) than never drinkers (only). Sensitivity analysis including participants initially excluded due to largely incomplete occupational histories did not change estimates, either for Europe or for Latin America; nor did multiple imputation for missing smoking and alcohol information only marginally changed estimates (data not shown).

DISCUSSION

We found consistently elevated risk associations for head and neck cancer with low occupational social prestige, low occupational socioeconomic position and manual work. These findings were only partly explained by smoking, alcohol drinking or working in recognised higher risk occupations. However, among the small subgroup of never smokers and never drinkers, the risks associated with lower social prestige and class were completely attenuated. The overall findings were stronger among men than women, for cancers of the larynx and hypopharynx, and observed in Europe, but not in Latin America.

Inequalities in health outcomes (including cancer) are driven by social determinants—by inequalities in income, wealth and power.[29] Our analysis taps into several of these domains, particularly the power relationships that arise from different occupational strata (captured here by social prestige), and shown to be important in health outcomes.[30]

SIOPS is based on the social prestige given to different occupational groupings. McCartney *et al* recently reappraised theories of social class and their application to the study of health inequalities.[31] They noted that SIOPS and ISEI, unlike traditional categorical occupational social class schemes, employ a continuous or gradational hierarchy—based on relative social advantage.[32] While ISEI captures more material aspects of socioeconomic position, as it is derived from education and income aspects of occupations, the use of the SIOPS ('prestige') measure enables more direct inference of the psychosocial dimension.[13–16] Although SIOPS, ISEI and manual versus non-manual reflect different socioeconomic 'class' dimensions, they all are occupation-based indices and are known to be strongly correlated.[25] We found the strongest head and neck cancer risk associations for prestige, with socioeconomic position and manual occupations slightly lower. This points to the importance of psychosocial and material dimensions of occupational socioeconomic relationship with head and neck cancer, although the environmental aspect is also relevant.

While there are recognised head and neck cancer risk associations with certain occupations,[27] we found only a limited inter-relationship between occupational risk and the socioeconomic dimensions of occupations. Earlier studies suggested that occupational exposures were responsible for about one-third of total cancer difference between high and low socioeconomic groups.[33] In our data, for head and neck cancer, occupational exposures attenuated the socioeconomic excess risk associations (model 4 vs model 3) by around 20%. However, this type of comparison of estimates may be biased in logistic regression models.[34 35]

Smoking is undoubtedly a major risk factor for head and neck cancer[6] and a major explanatory factor for all socioeconomic health inequalities.[10] Alcohol consumption also compounds head and neck cancer risk,[6 7] and clustering of these risk factors is also observed in lower socioeconomic groups.[11] We observed, following thorough adjustment of many dimensions of smoking and alcohol behaviours, that the risk associations with occupational socioeconomic measures reduced (but not fully). Elevated head and neck cancer risks associated with lower socioeconomic positions among never

Table 1 Characteristics of participants by sex and case–control status

	Men				Women				Overall			
	Cases		Controls		Cases		Controls		Cases		Controls	
	N	%	n	%	N	%	n	%	n	%	N	%
Total	5185	39.5	6063	46.1	633	4.8	1263	9.6	5818	44.3	7326	55.7
Study												
France multicentre (1989–1991)	485	9.4	277	4.6	0	0.0	0	0.0	485	8.3	277	3.8
France multicentre (2001–2007)	1781	34.3	2695	44.4	202	31.9	634	50.2	1983	34.1	3329	45.4
Germany-Heidelberg	208	4.0	694	11.4	14	2.2	49	3.9	222	3.8	743	10.1
Latin America	1420	27.4	1021	16.8	163	25.8	173	13.7	1583	27.2	1194	16.3
Western Europe	1291	24.9	1376	22.7	254	40.1	407	32.2	1545	26.6	1783	24.3
Age (years)												
Median (IQR)	58 (52–65)		59 (52–67)		59 (52–66)		61 (51–69)		58 (52–65)		60 (52–67)	
Smoking status (cigarettes)												
Never smokers	215	4.1	1748	28.8	148	23.4	751	59.5	363	6.2	2499	34.1
Former smokers	1658	32.0	2807	46.3	106	16.7	267	21.1	1764	30.3	3074	42.0
Current smokers	3312	63.9	1508	24.9	379	59.9	245	19.4	3691	63.4	1753	23.9
Cigarettes smoked per day												
Median (IQR)	20 (15–29)		10 (0–20)		12 (1–20)		0 (0–10)		20 (13–28)		9 (0–19)	
Years of cigarette smoking												
Median (IQR)	37 (30–44)		19 (0–34)		32 (5–40)		0 (0–21)		37 (29–44)		16 (0–32)	
Cigarette pack-years												
Median (IQR)	37 (24–54)		11 (0–29)		19 (1–36)		0 (0–10)		36 (21–53)		8 (0–26)	
Drinking status												
Never	192	3.7	455	7.5	132	20.9	369	29.2	324	5.6	824	11.2
Ever	4993	96.3	5608	92.5	501	79.1	894	70.8	5494	94.4	6502	88.8
Number of drinks (15.6 mL of ethanol) per day												
Never drinkers	192	3.7	455	7.5	132	20.9	369	29.2	324	5.6	824	11.2
0< drinks/day <1	723	13.9	2140	35.3	284	44.9	694	54.9	1007	17.3	2834	38.7
1≤ drinks/day <3	1240	23.9	1973	32.5	130	20.5	168	13.3	1370	23.5	2141	29.2
3≤ drinks/day <5	968	18.7	773	12.7	38	6.0	18	1.4	1006	17.3	791	10.8
≥5 drinks/day	2062	39.8	722	11.9	49	7.7	14	1.1	2111	36.3	736	10.0
Cancer subtypes												
Oral cavity	929	17.9			210	33.2			1139	19.6		
Oropharynx	1089	21.0			192	30.3			1281	22.0		
Hypopharynx	795	15.3			32	5.1			827	14.2		
Oral/pharynx NOS	342	6.6			59	9.3			401	6.9		
Larynx	1968	38.0			135	21.3			2103	36.1		
Overlapping head and neck	52	1.0			4	0.6			56	1.0		
Missing	10	0.2			1	0.2			11	0.2		
Control type												
Hospital based			2409	39.7			478	37.8			2887	39.4
Population based			3654	60.3			785	62.2			4439	60.6
Study region												
Europe	3765	72.6	5042	83.2	470	74.2	1090	86.3	4235	72.8	6132	83.7
Latin America	1420	27.4	1021	16.8	163	25.8	173	13.7	1583	27.2	1194	16.3
SIOPS*												
1st quartile (m: 51–78/w: 49–78/overall: 49–78)	489	9.4	1520	25.1	109	17.2	307	24.3	636	10.9	1900	25.9
2nd quartile (m: 41–50/w: 40–48/overall: 40–48)	971	18.7	1408	23.2	152	24.0	346	27.4	1318	22.7	1957	26.7
3rd quartile (m: 32–40/w: 26–39/overall: 31–39)	1534	29.6	1384	22.8	158	25.0	303	24.0	2082	35.8	1841	25.1
4th quartile (m: 14–31/w: 14–25/overall: 14–30)	2191	42.3	1751	28.9	214	33.8	307	24.3	1782	30.6	1628	22.2
ISEI*												
1st quartile (m: 55–90/w: 56–90/overall: 56–90)	583	11.2	1569	25.9	100	15.8	313	24.8	659	11.3	1801	24.6
2nd quartile (m: 39–54/w: 45–55/overall: 40–55)	1086	20.9	1550	25.6	138	21.8	310	24.5	1177	20.2	1872	25.6
3rd quartile (m: 32–38/w: 28–44/overall: 32–39)	1900	36.6	1585	26.1	188	29.7	308	24.4	2096	36.0	1875	25.6

Continued

Table 1 Continued

	Men				Women				Overall			
	Cases		Controls		Cases		Controls		Cases		Controls	
	N	%	n	%	N	%	n	%	n	%	N	%
4th quartile (m:10–31/w:10–27/overall: 10–31)	1616	31.2	1359	22.4	207	32.7	332	26.3	1886	32.4	1778	24.3
Longest job was manual												
Yes	3993	77.0	3503	57.8	398	62.9	642	50.8	4391	75.5	4145	56.6
No	1192	23.0	2560	42.2	235	37.1	621	49.2	1427	24.5	3181	43.4
Worked ≥10 years in risk occupations												
Yes	1947	37.6	1418	23.4	138	21.8	213	16.9	2085	35.8	1631	22.3
No	3238	62.4	4645	76.6	495	78.2	1050	83.1	3733	64.2	5695	77.7
Ever experienced unemployment†												
Yes	402	12.3	345	7.2	42	8.9	83	7.6	444	11.8	428	7.3
No	2878	87.7	4420	92.8	428	91.1	1007	92.4	3306	88.2	5427	92.7

*Status/prestige score for longest job, categories by sex specific and overall quartiles of control group.
†No data available for Latin America and France (1989–1991).
ISEI, International Socio-Economic Index; NOS, not otherwise specified; SIOPS, Standard International Occupational Prestige Scale.

smokers and/or never alcohol drinkers suggest some potential residual effects of smoking and alcohol consumption. However, it should be noted that there are very small numbers of never smokers and never drinkers which make this estimate less reliable. Non-linearity of smoking and alcohol could risk misspecification and residual confounding[36] —we undertook a post-hoc analysis with log-transformed smoking and alcohol variables which did not change the socioeconomic factors' risk association (data not shown). Stronger socioeconomic risk associations for hypopharynx and larynx cancers compared with oral cavity and oropharynx cancers point to a dominant role of smoking in explaining these associations. A previous INHANCE analysis showed that smoking had a significantly greater risk association for laryngeal cancer than oral cavity/pharynx cancer.[37] However, because alcohol and smoking are highly correlated, when adjusting for smoking, there is likely to be some adjustment for alcohol drinking, so alcohol's role in contributing to inequalities in head and neck cancer cannot be discounted.

Health inequalities and cancer risks associated with socioeconomic factors have generally been observed to be stronger among men than women.[38] Our study is no exception, the likely explanations include lack of data in women, and particular difficulties in older generations in classifying women by occupational social classifications,[13] reflected in the male database that was used for construction of SIOPS/ISEI.[24 25] Suggestions that health inequalities affect women to a lesser degree are increasingly recognised as unfounded.[39 40]

Our finding of a lower risk association in Latin America was unexpected as it contradicted those of the original publication of socioeconomic analysis of the data[40] —which found elevated ORs associated with non-manual ('social class') occupations. The socioeconomic distribution of controls was different from the other studies, that is, the Latin American controls were generally

Table 2 Adjusted ORs and 95% CIs for the association between occupational socioeconomic measures and socioeconomic status and head and neck cancer

	Cases	Controls	Model 1* OR (95% CI)	Model 2† OR (95% CI)	Model 3‡ OR (95% CI)	Model 4§ OR (95% CI)	Model 5¶ OR (95% CI)
SIOPS**							
1st quartile (49–78)	636	1900	1.00	1.00	1.00	1.00	1.00
2nd quartile (40–48)	1318	1957	1.89 (1.68 to 2.12)	1.59 (1.39 to 1.81)	1.57 (1.38 to 1.80)	1.55 (1.36 to 1.76)	1.45 (1.23 to 1.71)
3rd quartile (31–39)	2082	1841	2.79 (2.49 to 3.13)	2.00 (1.76 to 2.27)	1.95 (1.72 to 2.22)	1.82 (1.59 to 2.07)	1.58 (1.30 to 1.92)
4th quartile (14–30)	1782	1628	2.77 (2.46 to 3.12)	2.12 (1.86 to 2.42)	2.08 (1.82 to 2.37)	1.88 (1.64 to 2.17)	1.59 (1.30 to 1.94)
ISEI**							
1st quartile (56–90)	659	1801	1.00	1.00	1.00	1.00	1.00
2nd quartile (40–55)	1177	1872	1.64 (1.46 to 1.85)	1.43 (1.25 to 1.63)	1.42 (1.24 to 1.62)	1.38 (1.21 to 1.58)	1.01 (0.85 to 1.20)
3rd quartile (32–39)	2096	1875	2.49 (2.22 to 2.79)	1.85 (1.63 to 2.10)	1.80 (1.59 to 2.05)	1.68 (1.47 to 1.91)	1.05 (0.84 to 1.31)
4th quartile (10–31)	1886	1778	2.45 (2.19 to 2.76)	1.98 (1.73 to 2.25)	1.93 (1.69 to 2.20)	1.74 (1.51 to 1.99)	1.11 (0.88 to 1.40)
Ever manual job							
No	1427	3181	1.00	1.00	1.00	1.00	1.00
Yes	4391	4145	1.99 (1.83 to 2.15)	1.64 (1.50 to 1.80)	1.61 (1.47 to 1.76)	1.49 (1.35 to 1.64)	1.15 (0.99 to 1.34)
Ever unemployed††							
No	3306	5427	1.00	1.00	1.00	1.00	1.00
Yes	444	428	1.85 (1.60 to 2.13)	1.37 (1.16 to 1.61)	1.26 (1.06 to 1.50)	1.24 (1.04 to 1.47)	1.19 (1.00 to 1.41)

*Adjustment for sex, age and study centre.
†Variables of model 1 and further adjustment for cigarette smoking (status, duration, cigarettes/day, pack-years).
‡Variables of model 2 and further adjustment for alcohol consumption (status, drinks/day, interaction drinks/day×duration cigarette smoking).
§Variables of model 3 and further adjustment for worked ≥10 years in risk occupations (10 years before study).
¶Variables of model 4 and further adjustment for respective other SES/prestige variables (SIOPS, ISEI, manual/non-manual).
**Scores for longest job, categories based on quartiles of control distribution.
††No data available for Latin America and France (1989–1991).
ISEI, International Socio-Economic Index; SES, socioeconomic status; SIOPS, Standard International Occupational Prestige Scale.

Table 3 Stratified analyses of the association between occupational socioeconomic prestige (SIOPS*) and head and neck cancer

	Cases	Controls	OR (95% CI)†	Cases	Controls	OR (95% CI)†
A						
Sex p=0.051‡	Men			Women		
1st quartile (m: 51–78/w: 49–78)§	489	1520	1	109	307	1
2nd quartile (m: 41–50/w: 40–48)§	971	1408	1.55 (1.34 to 1.81)	152	346	1.27 (0.91 to 1.77)
3rd quartile (m: 32–40/w: 26–39)§	1534	1384	1.98 (1.70 to 2.30)	158	303	1.18 (0.84 to 1.66)
4th quartile (m: 14–31/w: 14–25)§	2191	1751	1.99 (1.71 to 2.30)	214	307	1.48 (1.00 to 2.19)
Study region p<0.001‡	Europe			Latin America		
1st quartile (49–78)	564	1819	1	72	81	1
2nd quartile (40–48)	1035	1763	1.42 (1.23 to 1.63)	283	194	1.41 (0.93 to 2.15)
3rd quartile (31–39)	1507	1447	1.71 (1.48 to 1.98)	575	394	1.21 (0.82 to 1.80)
4th quartile (14–30)	1129	1103	1.80 (1.54 to 2.11)	653	525	1.21 (0.81 to 1.81)
Type of study p<0.001‡	Hospital based			Population based		
1st quartile (49–78)	301	432	1	335	1468	1
2nd quartile (40–48)	717	682	1.20 (0.97 to 1.47)	601	1275	1.58 (1.32 to 1.90)
3rd quartile (31–39)	1241	855	1.27 (1.04 to 1.56)	841	986	1.98 (1.65 to 2.39)
4th quartile (14–30)	1085	918	1.18 (0.95 to 1.46)	697	710	2.35 (1.93 to 2.86)
Ever/never smoked cigarettes p=0.132‡	Ever smoked ≥100 cigarettes			Never smoked ≥100 cigarettes		
1st quartile (49–78)	561	1175	1	75	725	1
2nd quartile (40–48)	1212	1271	1.57 (1.36 to 1.82)	106	686	1.34 (0.96 to 1.86)
3rd quartile (31–39)	2004	1320	1.89 (1.64 to 2.18)	78	521	1.21 (0.84 to 1.73)
4th quartile (14–30)	1678	1061	1.96 (1.68 to 2.28)	104	567	1.34 (0.92 to 1.94)
Ever/never drank alcohol¶ p=0.123‡	Ever drank alcohol			Never drank alcohol		
1st quartile (49–78)	596	1758	1	40	142	1
2nd quartile (40–48)	1254	1761	1.59 (1.39 to 1.82)	64	196	0.92 (0.55 to 1.52)
3rd quartile (31–39)	2002	1667	1.85 (1.61 to 2.12)	80	174	1.29 (0.77 to 2.14)
4th quartile (14–30)	1642	1316	1.89 (1.64 to 2.19)	140	312	1.57 (0.95 to 2.61)
Ever/never manual p=0.231‡	Ever worked in manual job			Never worked in manual job		
1st quartile (49–78)	335	800	1	301	1100	1
2nd quartile (40–48)	1083	1502	1.40 (1.17 to 1.66)	235	455	1.34 (1.05 to 1.72)
3rd quartile (31–39)	2040	1748	1.67 (1.41 to 1.97)	42	93	1.06 (0.66 to 1.71)
4th quartile (14–30)	1759	1592	1.73 (1.45 to 2.06)	23	36	1.47 (0.77 to 2.81)

	Cases	Controls	OR (95% CI)†	Cases	Controls	OR (95% CI)†	Cases	Controls	OR (95% CI)†	Cases	Controls	OR (95% CI)†
Tumour subsite	Oral cavity		Oropharynx				Hypopharynx			Larynx		
B												
1st quartile (49–78)	134	1900	1.00	166	1900	1	73	1900	1	223	1900	1
2nd quartile (40–48)	270	1957	1.53 (1.21 to 1.94)	288	1957	1.38 (1.11 to 1.72)	181	1957	1.91 (1.41 to 2.59)	480	1957	1.61 (1.33 to 1.96)
3rd quartile (31–39)	401	1841	1.84 (1.45 to 2.33)	430	1841	1.67 (1.34 to 2.08)	297	1841	2.29 (1.70 to 3.08)	791	1841	1.94 (1.60 to 2.35)
4th quartile (14–30)	334	1628	1.63 (1.27 to 2.09)	397	1628	1.68 (1.34 to 2.11)	276	1628	2.61 (1.92 to 3.55)	609	1628	1.96 (1.60 to 2.42)
Combining ever/never smoking and drinking** p=0.052‡	Ever smoked cigarettes, ever drank alcohol		Ever smoked cigarettes, never drank alcohol				Never smoked cigarettes, ever drank alcohol			Never smoked cigarettes, never drank alcohol		
1st quartile (49–78)	539	1109	1	22	66	1	57	649	1	18	76	1

Continued

Table 3 Continued

Tumour subsite	Cases	Controls	OR (95% CI)†	Cases	Controls	OR (95% CI)†	Cases	Controls	OR (95% CI)†	Cases	Controls	OR (95% CI)†
	Oral cavity		Oropharynx				Hypopharynx			Larynx		
2nd quartile (40–48)	1164	1173	1.58 (1.36 to 1.83)	48	98	1.30 (0.67 to 2.52)	90	588	1.56 (1.08 to 2.25)	16	98	0.53 (0.24 to 1.19)
3rd quartile (31–39)	1938	1240	1.88 (1.63 to 2.18)	66	80	2.02 (1.05 to 3.90)	64	427	1.41 (0.94 to 2.12)	14	94	0.59 (0.25 to 1.39)
4th quartile (14–30)	1568	934	1.91 (1.63 to 2.23)	110	127	2.57 (1.32 to 5.01)	74	382	1.63 (1.07 to 2.48)	30	185	0.54 (0.23 to 1.23)

*Longest job, categories based on quartiles of control distribution.
†ORs and 95% CIs adjusted for sex, age, study centre, cigarette smoking (status, duration, cigarettes/day, pack-years), alcohol consumption (ever/never, drinks/day), an interaction term drinks/day×duration cigarette smoking) and worked ≥10 years in risk occupations (10 years before study).
‡Test of interaction between stratification factor and SIOPS.
§Categories separately for SIOPS distribution in control groups for men (m) and women (w).
¶Ever/never drank >15.6 mL of ethanol.
**Ever/never smoked ≥100 cigarettes in lifetime and ever/never drank alcohol (>15.6 mL of ethanol).
SIOPS, Standard International Occupational Prestige Scale.

from lower socioeconomic groups, and more similar to the case distribution. Post-hoc analysis, building SIOPS/ISEI quartiles based on the Latin American control distribution (rather than overall control distribution) did not change the findings. The Latin American study employed hospital controls, which we found overall had lower risks (consistent across SIOPS and ISEI). In a further post-hoc analysis, removing the Latin America data from the stratified analysis, the ORs for hospital controls did not change, which could indicate that type of recruitment accounted for the difference rather than study region. Moreover, this continental difference observed was unlikely to be due to conceptual sociological differences in the measures across the countries—as SIOPS has been shown to be stable across very diverse cultures,[24] and ISEI was validated internationally (including Brazil).[25]

Our study has several strengths, including the relatively large size with nearly 6000 cases and over 7000 controls from five robust well-designed multicentre case–control studies with harmonised data.[17 41] The large size of the study with good quality socioeconomic and behavioural risk factor data enabled risk estimates to be examined and confounders to be thoroughly adjusted for. Analyses method strengths included multiple sensitivity analyses to test the robustness of the results.

There were also limitations of this study including unquantifiable measurement errors, data availability limitations and residual confounding. We were only able to include 5 of the possible 35 studies in INHANCE, with no studies from North America or indeed South Asia.[41] Included studies had to have prior ISCO-coded occupational histories. The occupational risks derived from these codes are probably too imprecise to indicate specific exposure to occupational carcinogens, so residual confounding is a possibility. It was also not possible to examine the industrial dimensions of occupations in this study as have previously been shown to be related to socioeconomic inequalities in cancer incidence.[42 43] Lifetime duration of alcohol (even over a short period) has begun to be shown to increase cancer risk,[44] however, this variable was missing from some of the studies and could not be included in the analysis. Data on HPV were also not available for the studies in this analysis and could be an important factor particularly in relation to oropharyngeal risks.[8 9] Recall bias is also a possibility, although it is unlikely that cases reported their occupational history differently from controls.[27] In addition, periods of housework or part-time work (more common among women) were excluded and could have underestimated socioeconomic effects.[45] Selection bias could potentially impact the findings particularly in the hospital-based centres where the controls are potentially of similar socioeconomic and risk behaviour profiles to the case participants. Indeed, our findings were stronger in study centres with population-based design. Previous INHANCE socioeconomic analyses of income and education found no differences between hospital and population-based controls reassuring against the risk of selection bias, and the measures undertaken in the studies which used hospital-based control sampling to reduce selection bias included recruiting patients attending hospital not for cancer nor conditions related to the main behavioural risk factors.[10] Finally, SIOPS and ISEI have not been updated since their creation in the late 20th century, and may not reflect recent occupational socioeconomic structures. However, the indices used were appropriate for the decades when most of the participants were employed, and job ranking by SIOPS has been shown to be consistent over time.[24] There has been a general shift from manual to low-level service occupations which may not be captured by these socioeconomic measures, although this would have had a minimal impact as our data were largely collected in the early 2000s (with mean participant age of 50–60 years) and further analyses of trajectories of occupational socioeconomic prestige could be subsequently undertaken.

CONCLUSIONS

Our results indicate that occupational socioeconomic prestige, position and manual work are associated with head and neck cancer, and this risk is only partly explained by smoking and alcohol exposure. Occupational exposures were not a major explanatory factor as expected given the occupational source of our socioeconomic measures. This points to the importance of psychosocial impacts of socioeconomic factors as well as the more recognised material dimension in head and neck cancer risk. The implications of these results could also extend to the inclusion of psychosocial/socioeconomic occupational factors in the future development of head and neck cancer risk assessment/prediction tools, and to informing prevention and early detection efforts.

What is already known on this subject

- The association between socioeconomic disadvantage (measured by low education and/or income) and head and neck cancer risk is well established.
- Less is known on the risks of head and neck cancer associated with socioeconomic aspects of occupations and the inter-relationship with occupational exposures.

What this study adds

- Low occupational socioeconomic prestige and position, and manual work are associated with head and neck cancer, and such risks are only partly explained by smoking, alcohol and occupational exposures.
- Perceptual occupational psychosocial status (Standard International Occupational Prestige Scale) appears to be strongest socioeconomic factors relative to socioeconomic position and manual/non-manual work.
- Implications could extend to the inclusion of psycho-socioeconomic occupational factors in future development of head and neck cancer risk prediction tools, and to informing prevention and early detection strategies.

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